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ESTIMATING SURVIVAL OF BIRD CARCASSES IN CATTAIL MARSHES

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In North Dakota, South Dakota, and Minnesota, blackbirds (Icterinae) cause extensive damage to ripening sunflower (Hothem et al. 1988). In some cases, lethal control is being considered to reduce roosting blackbird populations using cattail (*Typha* spp.) marshes located near sunflower fields (Linz et al. 1988, Cummings and Schafer 1989). The use of herbicides for eliminating blackbird roosting and nesting habitat is another method being considered for reducing the impact of blackbirds on sunflower (Linz and Bergman 1991). The nontarget hazards associated with pesticide applications in and adjacent to marshes are a concern and must be monitored (Grue et al. 1986). Therefore, reliable estimates of target and nontarget animal mortality must be obtained to evaluate the effects of pesticide applications.

Two factors that may affect the accuracy of mortality estimates are the number of carcasses removed by scavengers (Balcomb 1986, Fite et al. 1988, Heisterberg et al. 1990) and the ability of searchers to find small carcasses (Fite et al. 1988). Some researchers have placed carcasses in marshes to estimate the level of scavenging activity (Avery 1974, Heijnis 1976, Avery et al. 1978, Meyer 1978, James and Haak 1979, Cassel et al. 1979, Beaulaurier 1981, Faanes 1987). Heijnis (1976), Cassel et al. (1979), and James and Haak (1979) obtained an index of searcher ability to find carcasses in wetlands. However, to our knowledge, no systematic studies of searcher efficiency and carcass removal by scavengers in cattail marshes have been conducted.

During August and September 1987, we placed intact bird carcasses in cattail marshes in Benson and Pierce counties, North Dakota to (1) estimate carcass longevity, (2) determine the effects of carcass density on carcass longevity, (3) determine if longevity of carcasses is dependent on water depth, and (4) provide an estimate of the ability of searchers to find bird carcasses in cattail marshes.

STUDY AREA AND METHODS

The study is located in the prairie pothole region of North Dakota (Stewart 1975). The numerous marshes scattered throughout this region are surrounded by farm land. One permanent (Class V) and 7 semipermanent marshes (Class IV) were used to study carcass longevity (classification of Stewart and Kantrud 1971). One of these semipermanent marshes and 1 other semipermanent marsh were used for the search efficiency trials. Seven of the semipermanent marshes and the permanent marsh had open water interspersed with emergent vegetation. The remaining semipermanent marsh was covered by a dense stand of cattails.

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Carcass Longevity

In 4 marshes, designated as low carcass density marshes, 15 freshly killed or previously frozen and thawed blackbird carcasses (largely red-winged blackbird, *Agelaius phoeniceus*) were placed randomly in vegetation along the marsh edge. In 4 other marshes, designated as high carcass density marshes, 5 carcasses were randomly dropped in the vegetation within each of 15 2 × 5 m plots (plots >30 m apart). A wooden stake was placed about 30 cm from each bird in all marshes. The depth of water under each carcass was measured to the nearest 3 cm. Starting the following day (day 1), each carcass was checked daily for 6 (1 marsh) or 7 consecutive days or until it disappeared. Carcasses were recorded as intact, partially scavenged, or removed without a trace.

We analyzed the data for removal time, which is defined as that time between placement to complete removal of the carcass. Removal time is an important variable in assessing the potential nontarget secondary hazards from a pesticide treatment (Balcomb 1983) and must be considered when estimating mortality of target and nontarget species (Fite et al. 1988).

We analyzed removal of carcasses by the product-limit life table method (Kaplan and Meier 1958) using the LIFETEST procedure in the SAS program package (SAS Inst. Inc. 1988). The resulting curves were compared using a Wilcoxon test modified for censoring by Breslow (1970). For the purposes of these analyses, a censored carcass was any carcass still in the marsh after the study was completed. Because water depth may hinder scavenging activity, and therefore may influence removal time, we grouped each marsh into 1 of 3 categories based on mean water depth: ≤15 cm, >15 <30 cm, and >30 cm. Next, we analyzed carcass longevity in high carcass density marshes and low carcass density marshes for a given water depth.

Searcher Efficiency

In 2 marshes we placed 5 2 × 5 m plots at uniform intervals along each of 16 transects placed in dense vegetation. In 1 subgroup of 8 transects within each marsh, we randomly distributed 40 male and 40 female red-winged blackbird carcasses within the 40 plots (range = 1–4). We allocated 160 male and 160 female carcasses to the other subgroup of 8 transects, placing an average of 8 (range = 2–15) carcasses in each plot.

Four searchers, all with unimpaired vision, conducted all the searches. All searchers had previous experience in searching for dead animals in dense vegetation. Before the 4 trials, the searchers were randomly assigned 2 adjacent transects (10 plots). Results from these 10 plots were pooled to produce the basic unit of response; i.e., percentage of males and females found. After searching these 2 transects, the searchers moved to the next 2 adjacent transects and searched. Searchers were informed that carcasses were placed in at least 1 plot but were not told carcass density or distribution. Searchers left all carcasses in their original location.

Randomized block analysis of variance (ANOVA), with marshes as blocks, was used to test the hypothesis that average arcsin-transformed percentages found were equal in low and high density transect pairs. A 3-way ANOVA, with trials and searchers as independent factors and sex as a repeated measure, was also performed to test for differences in transformed percentages of carcasses found.

RESULTS

Carcass Longevity

Removal curves differed between carcass densities ($\chi^2 = 5.93$, 1 df, $P = 0.015$) (Fig. 1A). Twenty-four hours after placement, 90% (SD = 15%) of the carcasses remained in the high carcass density marshes, whereas 97% (SD = 8%) of the carcasses persisted in the low carcass density marshes. By the end of the 7-day monitoring period, 47% (SD = 29%) of the carcasses remained in the high carcass density marshes, while 62% (SD = 24%) remained in the low carcass density marshes.

Depth of water influenced removal time ($\chi^2 = 41.57$, 2 df, $P < 0.001$) over all sites (Fig. 1B). In the high carcass density marshes, removal time differed among depth categories ($\chi^2 = 57.08$, 2 df, $P < 0.001$), whereas in the low carcass density marshes (depths <15 and >30 cm only) the removal curves did not differ ($\chi^2 = 0.20$, 1 df, $P = 0.654$).

Through 7 days the same percentages of carcasses persisted in the high carcass density marshes and low carcass density marshes with >30 cm of water ($\chi^2 = 0.95$, 1 df, $P = 0.329$; Fig. 1C), averaging 68% (SD = 16%) on day 7. In marshes with water ≤15 cm (Fig. 1D), carcass removal times differed between high carcass density marshes and low carcass density marshes ($\chi^2 = 20.55$, 1 df, $P < 0.001$). After 7 days in these marshes, 20% (SD = 40%) of the carcasses remained in the high carcass density marshes and 60% (SD = 35%) of the carcasses remained in the low carcass density marshes.

Searcher Efficiency

Percentages of carcasses found in high and low density transects did not differ ($F = 2.15$; df = 1,12; $P = 0.168$), averaging 84% (SD = 9%) and 78% (SD = 13%), respectively. There was no difference among trials ($F = 1.18$; df = 3,9; $P = 0.370$) or searchers ($F = 1.34$; df = 3,9; $P = 0.321$). Searchers did find a larger percentage of males ($\bar{x} = 83\%$, SD = 10%) than females ($\bar{x} = 78\%$, SD = 12%) ($F = 4.62$; df = 1,9; $P = 0.060$). However, the percentage of males discovered fluctuated among trials without any obvious trend, while searcher efficiency for females steadily increased over time, from a low of 64% (SD = 5%) in trial 1 to 88% (SD = 7%) in trial 4. This difference in search efficiency over time was reflected in a significant sex by trial interaction ($F = 12.45$, df = 3,9; $P < 0.001$). Overall, searchers found 81% (SD = 11%) of the carcasses in the experiment.

DISCUSSION

Carcass Longevity

Our data show that, regardless of carcass density, scavenging was substantial and variable in North Dakota cattail marshes. As evidenced by tracks, various mammals fed on the carcasses. While avian predators may have found some of our blackbird carcasses, they are more likely to find debilitated birds that are often associated with pesticide poisoning (Bruggers et al. 1989).

As expected, scavengers foraging around the marshes found the carcasses placed in shallow water more often than those placed in deep water. Deep water probably hindered scavenging, thereby extending carcass longevity. These data indicate that depth of water in marshes should be considered when assessing scavenging rates.

Initially, scavengers removed carcasses rapidly from the high carcass density marshes, whereas scavenging in the low carcass density

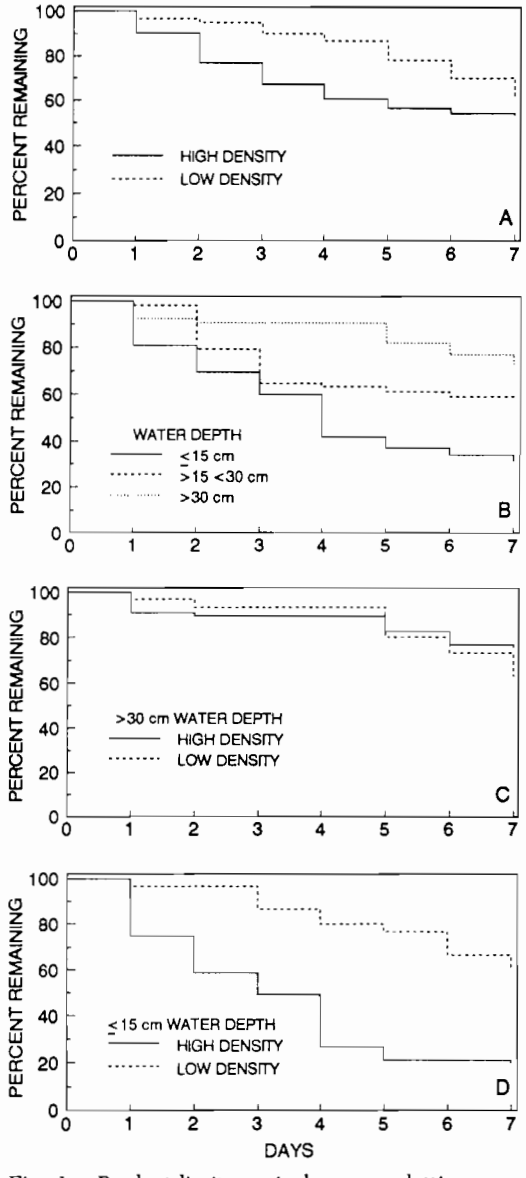

Fig. 1. Product-limit survival curves plotting percentage of red-winged blackbird carcasses remaining in cattail marshes versus time (days) for (A) low carcass density marshes (LCDM, 15 carcasses) and high carcass density marshes (HCDM, 75 carcasses); (B) among LCDM and HCDM in 3 water depth categories; (C) between LCDM and HCDM with >30 cm water depth; and (D) LCDM and HCDM marshes with ≤15 cm water depth.

marshes was slower and more uniform throughout the monitoring period. The clumped carcasses in the high carcass density marshes probably served as a strong attractant for scavengers which in turn contributed to initial rapid scavenging (Heijnis 1976).

We recognize that mammals may have followed our trail to the carcasses placed in shallow water. On the other hand, trap-shy predators may avoid a carcass tainted with human scent. This problem is an inherent part of carcass searches, especially where the same areas must be searched repeatedly. Because scavenging differs among marshes, an index of scavenging activity should be obtained for each treated marsh. We suggest that, immediately before the pesticide is applied, a known number of carcasses be placed and marked in the marsh. The number of removed carcasses can be used to estimate scavenging rates. The searches need to be conducted within 24 hours unless the nature of the pesticide used precludes early entry into the marsh.

While placing many dead animals in a marsh may attract scavengers to the marsh, at some carcass density the scavengers will be satiated and scavenging will level off or temporarily stop (Fite et al. 1988). Thus, the number of carcasses used to determine rate of scavenging should be guided by the expected number of dead animals. That is, the larger the anticipated mortality, the more carcasses needed to assess scavenging. In dense habitat, such as cattail marshes, avian predation or scavenging may be negligible. Thus, the information obtained from carcass disappearance studies will indicate mammal scavenging.

Carcass Searches

Our data indicate that in dense cattail stands experienced searchers will find an average of 81% of fresh red-winged blackbird carcasses placed in delineated plots. Male redwings are larger and have more brightly colored epaulets than females. Thus, it was not surprising that our searchers found more males than females. We expect that fewer carcasses would be found as distinguishing features of the birds (e.g., color) begin to disappear during decomposition.

Other studies indicate that morphological characteristics of the carcasses and habitat characteristics are important factors affecting the success of searchers. For example, James and Haak (1979) reported that searchers recovered 80% of the rock doves (*Columba livia*) and European starlings (*Sturnus vulgaris*) while finding only 30% of the smaller house sparrows (*Passer domesticus*) in wetland habitat. Cassel et al. (1979) and Tobin and Dolbeer (1990) found 64% of the house sparrows and 75% of the brown-headed cowbirds (*Molothrus ater*), respectively, placed in various upland locations.

Heijnis (1976) found that untrained searchers missed 28–38% more carcasses than experienced searchers. In our study, searcher proficiency in finding females increased with each succeeding trial, suggesting that practice improved their searching skills. On the other hand, it is puzzling that the percentage of males found did not increase with practice.

CONCLUSIONS

Bird carcasses were placed in 8 cattail marshes in North Dakota to estimate their longevity. We found that scavenging activity differs among marshes and is influenced by carcass density and depth of water under the carcasses. Thus, an index of scavenging activity should be obtained for each test site by placing carcasses throughout the marsh. If possible, daily searches for dead animals should be conducted to ensure reliable estimates of mortality.

The ability of searchers to find bird carcasses was also assessed. We conclude that searchers should practice looking for carcasses morphologically similar to those expected to be impacted. These practice searches should be con-

ducted in habitat similar to the proposed study site. A search efficiency index should be calculated for each searcher and mortality data adjusted to reflect differences in ability to find carcasses.

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LITERATURE CITED

AVERY, M. L. 1974. Investigations of bird migration and mortality at the Omega Navigation Station, LaMoure, North Dakota. M.S. Thesis, North Dakota State Univ., Fargo. 84pp.

———, P. F. SPRINGER, AND J. F. CASSEL. 1978. The composition and seasonal variation of bird losses at a tall tower in southeastern North Dakota. Am. Birds 32:1114–1121.

BALCOMB, R. 1983. Secondary poisoning of red-shouldered hawks with carbofuran. J. Wildl. Manage. 47:1129–1132.

———. 1986. Songbird carcasses disappear rapidly from agricultural fields. Auk 103:817–820.

BEAULAURIER, D. L. 1981. Mitigation of bird collisions with transmission lines. Bonneville Power Adm., Portland, Oreg. 83pp.

BRESLOW, N. 1970. A generalized Kruskal-Wallis test for comparing k samples subject to unequal patterns of censorship. Biometrika 57:579–594.

BRUGGERS, R. L., M. M. JAEGER, J. O. KEITH, P. L. HEGDAL, J. B. BOURASSA, A. A. LATIGO, AND J. N. GILLIS. 1989. Impact of fenthion on nontarget birds during quelea control in Kenya. Wildl. Soc. Bull. 17:149–160.

CASSEL, J. F., D. W. KIEL, J. J. KNODEL, AND J. M. WIEHE. 1979. Relations of birds to certain power transmission lines in central North Dakota. North Dakota State Univ., Fargo. 50pp.

CUMMINGS, J. L., AND E. W. SCHAFER, JR. 1989. Evaluation of a DRC-1347 (CPT) aerial spray application for reducing a roosting blackbird population. Pages 26–27 *in* Proc. Sunflower Res. Workshop, Natl. Sunflower Assoc., Bismarck, N.D.

FAANES, C. A. 1987. Bird behavior and mortality in relation to power lines in prairie habitats. U.S. Fish and Wildl. Serv. Tech. Rep. 7. 24pp.

FITE, E. C., L. W. TURNER, N. J. COOK, AND C. STUNKARD. 1988. Guidance document for conducting terrestrial field studies. U.S. Environ. Prot. Agency. Rep. 540/09-88-109. 67pp.

GRUE, C. E., L. R. DEWEESE, P. MINEAU, G. A. SWANSON, J. R. FOSTER, P. M. ARNOLD, J. N. HUCKINS, R. J. SHEEHAN, W. K. MARSHALL, AND A. P. LUDDEN. 1986. Potential impacts of agricultural chemicals on waterfowl and other wildlife inhabiting prairie wetlands: an evaluation of research needs and approaches. Trans. North Am. Wildl. and Nat. Resour. Conf. 51:357–383.

HEIJNIS, R. 1976. Birds under way . . . ornithological mortality and environmental aspects of aboveground high tension lines. Ornithol. Res. Found. 160pp. (translated from Dutch).

HEISTERBERG, J. F., J. L. CUMMINGS, G. M. LINZ, C. E. KNITTLE, T. W. SEAMANS, AND P. P. WORONECKI. 1990. Field trial of a CPT-avicide aerial spray. Proc. Vertebr. Pest Conf. 14:350–356.

HOTHEM, R. L., R. W. DEHAVEN, AND S. D. FAIRAIZL. 1988. Bird damage to sunflower in North Dakota, South Dakota, and Minnesota, 1979–1981. U.S. Fish and Wildl. Serv. Tech. Rep. 15. 11pp.

JAMES, B. W., AND B. A. HAAK. 1979. Factors affecting avian flight behavior and collision mortality at transmission lines. Bonneville Power Adm., Portland, Oreg. 109pp.

KAPLAN, E. L., AND P. MEIER. 1958. Nonparametric estimation from incomplete observations. J. Am. Stat. Assoc. 53:457–481.

LINZ, G. M., D. L. BERGMAN, S. T. SWANSON, AND W. J. BLEIER. 1991. Managing cattail marshes with glyphosate to reduce blackbird populations: 1990 update. Pages 76–85 *in* Proc. Sunflower Res. Workshop, Natl. Sunflower Assoc., Bismarck, N.D.

———, D. F. MOTT, AND E. W. SCHAFER, JR. 1988. Progress on the development of an avian toxicant (CPT). Pages 3–4 *in* Proc. Sunflower Res. Workshop, Natl. Sunflower Assoc., Bismarck, N.D.

MEYER, J. R. 1978. Effects of transmission lines on bird flight behavior and collision mortality. Bonneville Power Adm., Portland, Oreg. 200pp.

SAS INSTITUTE, INC. 1988. SAS user's guide: statistics. Release 6.03. SAS Inst. Inc., Cary, N.C. 1028pp.

STEWART, R. E. 1975. Breeding birds of North Dakota. Tri-College Center for Environmental Studies, Fargo, N.D. 295pp.

———, AND H. A. KANTRUD. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Bur. Sport Fish. and Wildl. Resour. Publ. 92. 57pp.

TOBIN, M. E., AND R. A. DOLBEER. 1990. Disappearance and recoverability of songbird carcasses in fruit orchards. J. Field Ornithol. 61:237–242.

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